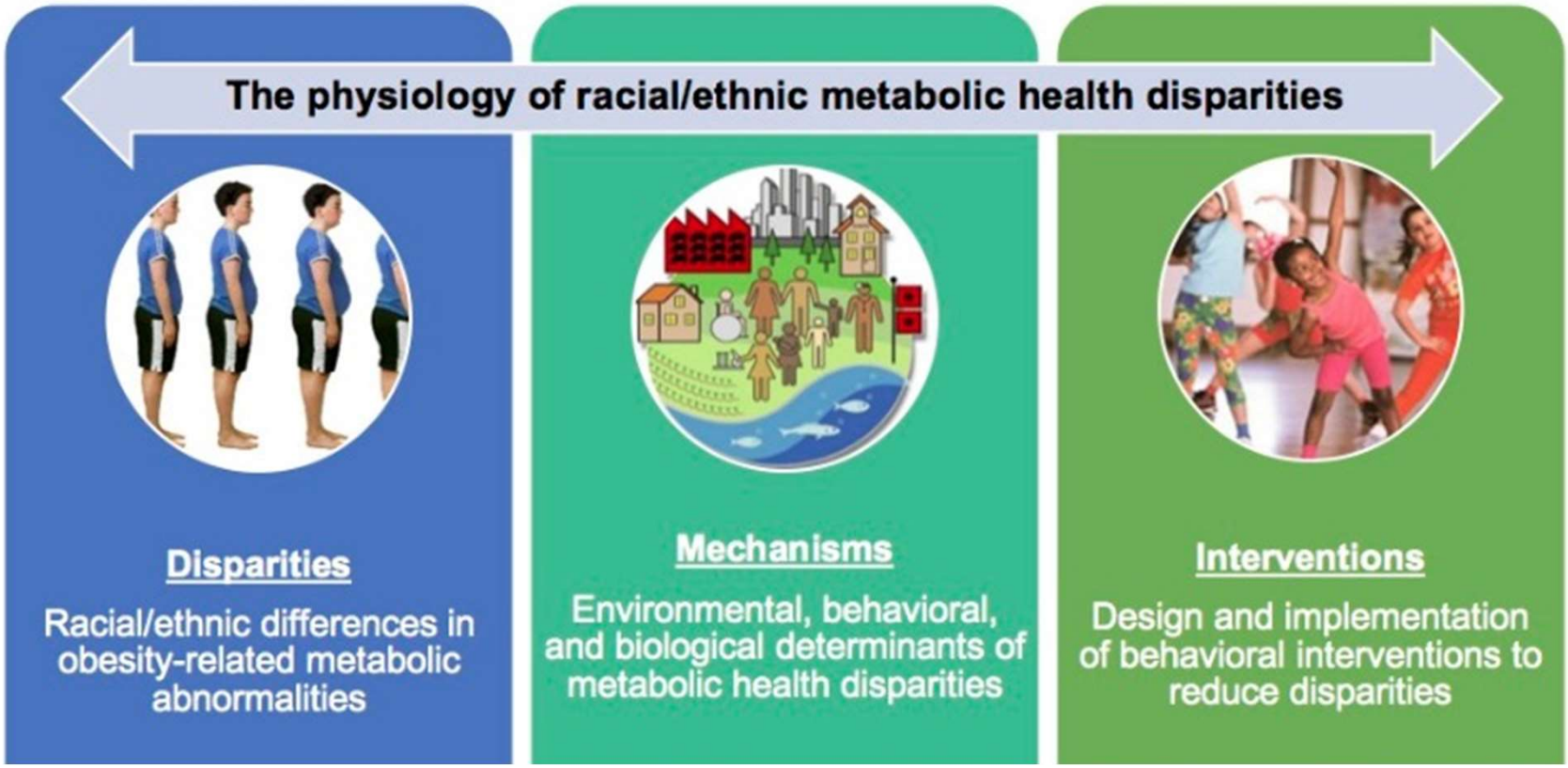
A biopsychosocial approach to examining child health disparities

Rebecca E. Hasson, PhD, FACSM

CHALLENGE THE IDLE STATE

SCHOOL OF KINESIOLOGY
UNIVERSITY OF MICHIGAN

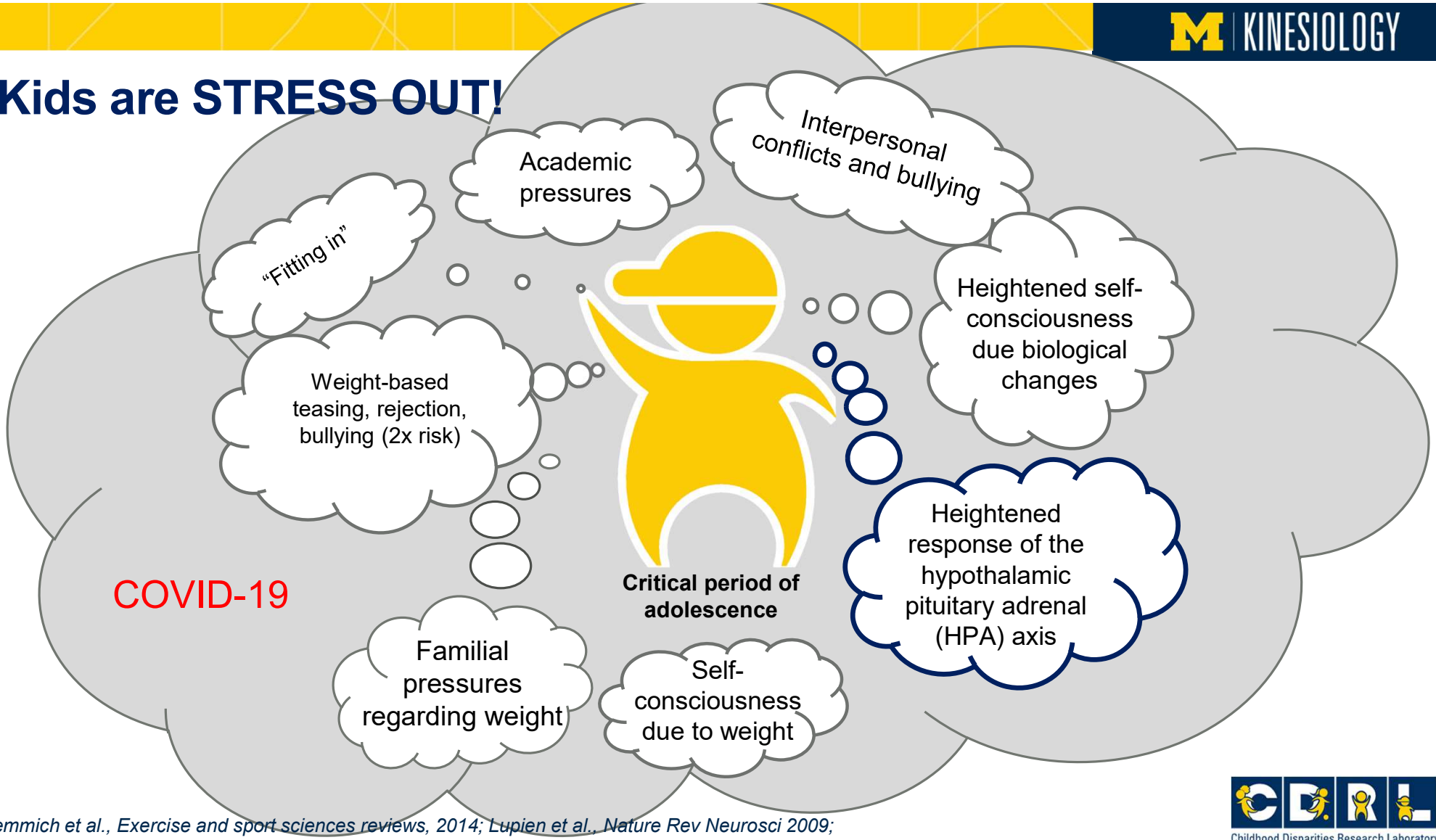
Translational research program



Research training

- University of Massachusetts, Amherst
  - Department of Kinesiology
- University of Southern California
  - Department of Preventive Medicine
- University of California San Francisco
  - Department of Family and Community Medicine

Kids are STRESS OUT!



Roemmich et al., Exercise and sport sciences reviews, 2014; Lupien et al., Nature Rev Neurosci 2009; Tomiyama, Appetite, 2014; Verdejo-Garcia et al., PlosOne, 2015

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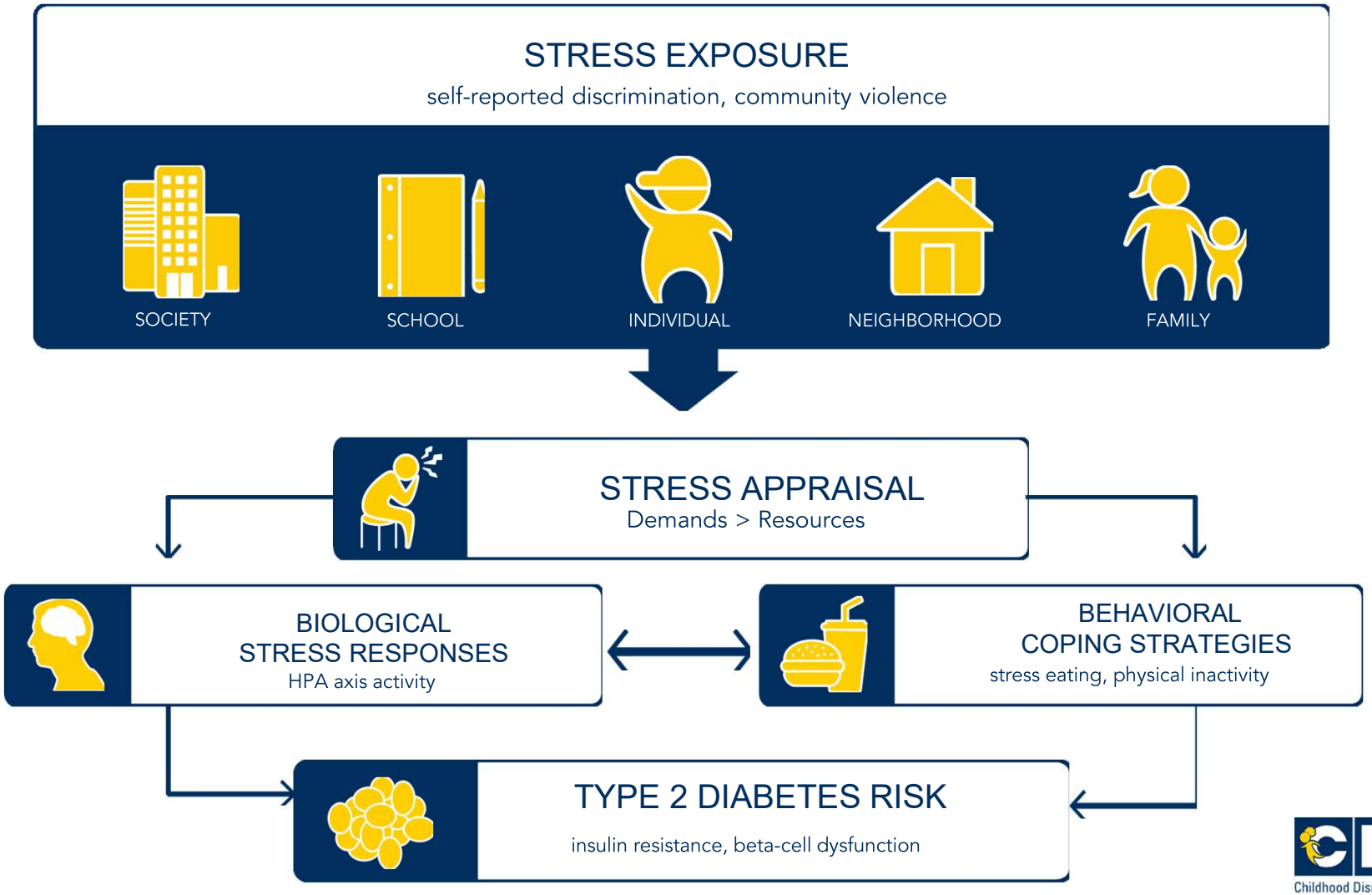

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Classic conceptualization of stress

Stress is a psychological process—a function of the individual's appraisals of the situation

An individual appraises a situation as threatening when his/her/their estimates of the **demands** presented by the situation are greater than the **resources** he/she/ they have available to meet those demands

DEMANDS > RESOURCES = STRESS

American Psychological Association, APA Working Group on Stress and Health Disparities, 2017

Classic conceptualization of stress

Stress can be perceived when the demands are:

- **Physical**- fighting off a physical attack
- **Psychological**- facing a loss, humiliation, or failure

Stress can be perceived when the demands are:

- **Unpredictable**
- **Uncontrollable**
- **Dangerous**

DEMANDS > RESOURCES = STRESS

American Psychological Association, APA Working Group on Stress and Health Disparities, 2017

Community violence

Physical threat to one's well being through

- Direct victimization
- Direct witnessing

Increased violence exposure within schools:

- Shooting
- Hearing gunshots
  - 62% of adolescents reported hearing gunshots

DEMANDS > RESOURCES = STRESS

Kliewer & Sullivan, Evid Based Pract Child Adolesc Ment Health, 2010; Kliewer et al., J Consult Clin Psychol, 1998; National Public Radio "Discrimination in America" 2011

Racial discrimination

Being treated unfairly because of one's race is a **psychological demand** directly affecting one's

- Self worth, sense of belonging
- Can also be classified as a **physical threat**

Being racially discriminated against within different contexts such as:

- School, peers, institutions

72% of adolescents report experiencing racial discrimination

DEMANDS > RESOURCES = STRESS

Sellers et al., J Health Soc Behav, 2003; Barnes & Lightsey, J Multicult Couns Devel 2005; National Public Radio "Discrimination in America" 2011

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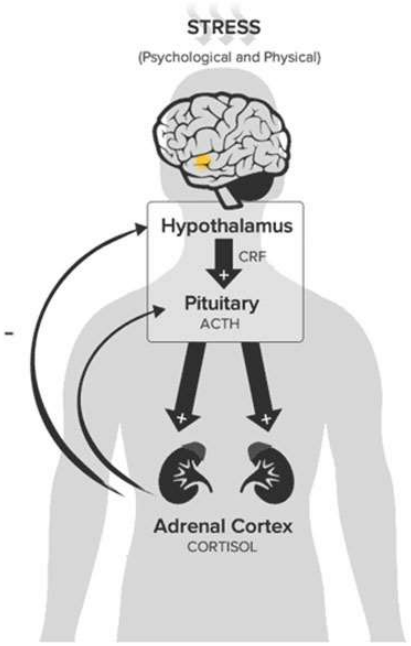
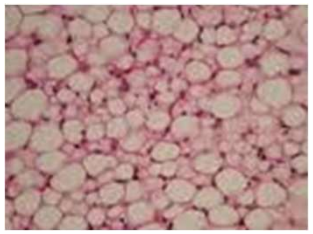
Cortisol and metabolic health



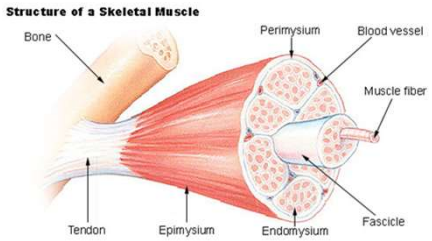
CORTISOL

Increases visceral fat accumulation



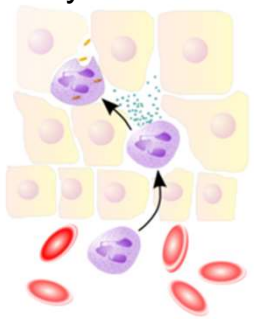
Adipose tissue

Inhibits insulin-dependent glucose uptake in the periphery



Skeletal muscle

Increases release of pro-inflammatory cytokines



Inflammation

MF Dallman et al., Front Neuroendocrinol, 1993; TC Adam et al., Physiology & Behavior, 2007; MH Antoni et al., Nature Reviews Cancer, 2006

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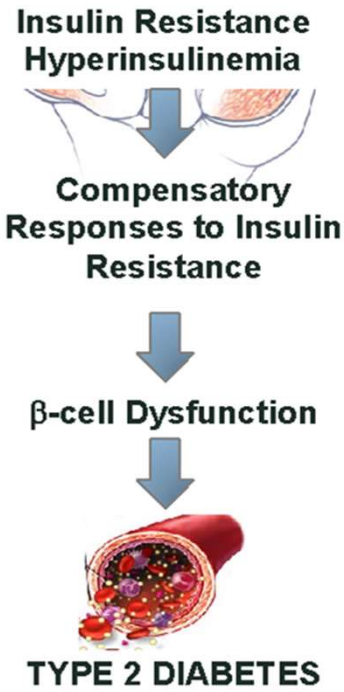
Chronic stress and type 2 diabetes risk

Short term glucocorticoid exposure

- Increase energy availability
- Inhibits insulin secretion
- Increases hepatic glucose output

Prolonged glucocorticoid exposure

- Directly inhibits insulin secretion from pancreatic beta-cells
- Impairs insulin-mediated glucose uptake
- Disrupts the insulin signaling cascade in skeletal muscle
- Increases visceral fat accumulation
- Increases release of pro-inflammatory cytokines



TC Adam and RE Hasson et al., JCEM, 2010 ; MF Dallman et al., Front Neuroendocrinol, 1993; TC Adam et al., Physiology & Behavior, 2007; MH Antoni et al., Nature Reviews Cancer, 2006

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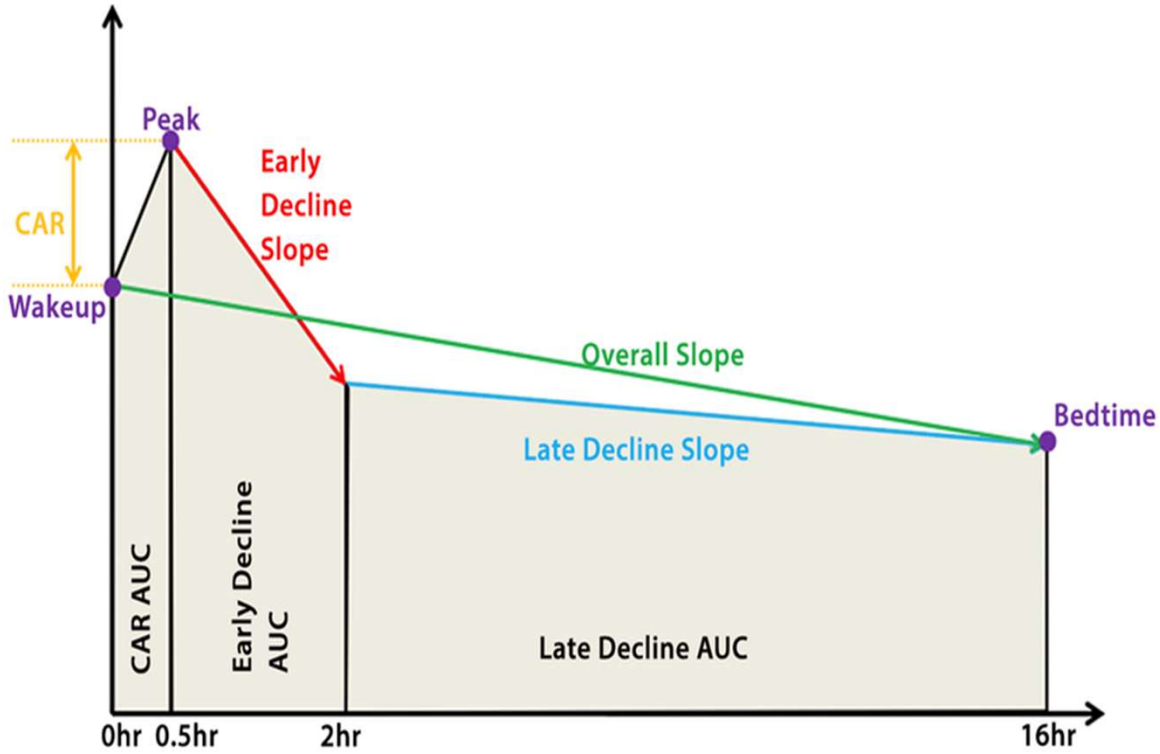
Diurnal cortisol response

Prolonged, high levels of psychological stress appraisals have been associated with dysregulated diurnal cortisol patterns

Portion of the diurnal cortisol pattern that is the **most sensitive to stress**

Directly related to:

- Blood glucose levels
- Insulin sensitivity
- Type 2 diabetes risk



Thorn et al., Psychoneuroendocrinology, 2006; Bruehl et al., Psychoneuroendocrinology, 2009; He et al., PLoS One, 2015

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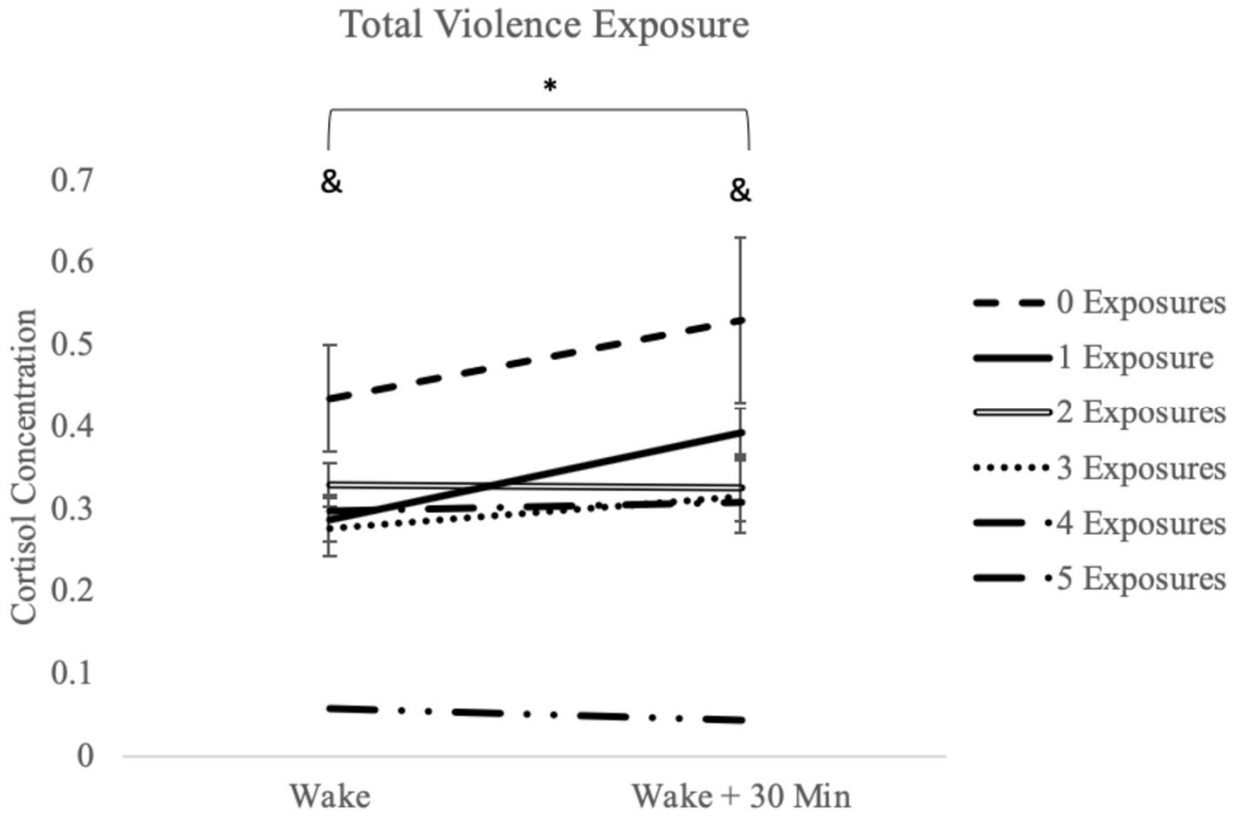
Community Violence and CAR



Covariates in analyses: sex, BMI, pubertal development, race, perceived stress

J Wexler et al., Psychoneuroendocrinology, 2020

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KINESIOLOGY

Racial discrimination

Racial Discrimination and Low Household Education Predict Higher Body Mass Index in African American Youth

Devin S. Nelson, BS,[1,2] Julia M. Gerras, BS,[1,2] Kellye C. McGlumphy,[1,2] Erika R. Shaver, MPH,[2,3] Amaanat K. Gill, BS,[1,2] Kamala Kanneganti, BS,[2] Tiwaloluwa A. Ajibewa, MS,[1,2] and Rebecca E. Hasson, PhD, FACSM[1–3]

Abstract

Objective: The purpose of this study was to examine the relationships between environmental factors, including household education, community violence exposure, racial discrimination, and cultural identity, and BMI in African American adolescents.

Methods: A community-based sample of 198 African American youth (120 girls, 78 boys; ages 11–19 years) from Washtenaw County, Michigan, were included in this analysis. Violence exposure was assessed by using the Survey of Children's Exposure to Community Violence; racial discrimination by using the Adolescent Discrimination Distress Index; cultural identity by using the Acculturation, Habits, and Interests Multicultural Scale for Adolescents; and household education by using a seven-category variable. Measured height and body weight were used to calculate BMI.

Results: Racial discrimination was positively associated with BMI, whereas household education was inversely associated with BMI in African American adolescents (discrimination: $\beta = 0.11 \pm 0.04$, $p = 0.01$; education: $\beta = -1.13 \pm 0.47$, $p = 0.02$). These relationships were significant when accounting for the confounding effects of stress, activity, diet, and pubertal development. Significant gender interactions were observed with racial discrimination and low household education associated with BMI in girls only (discrimination: $\beta = 0.16 \pm 0.05$, $p = 0.003$; education: $\beta = -1.12 \pm 0.55$, $p = 0.045$). There were no significant relationships between culture, community violence exposure, and BMI (all p's > 0.05).

Conclusion: Environmental factors, including racial discrimination and low household education, predicted higher BMI in African American adolescents, particularly among girls. Longitudinal studies are needed to better understand the mechanisms by which these environmental factors increase obesity risk in African American youth.

Keywords: adolescents; cultural identity; ethnicity; obesity; stress

PEER DISCRIMINATION
Any racial discrimination occurring between peers, especially of the same age
An example includes: "You were called racially insulting names."

EDUCATIONAL DISCRIMINATION
Any racial discrimination that took place in the school environment, not including peer discrimination.
An example includes: "You were given a lower grade than what was deserved."

INSTITUIONAL DISCRIMINATION
Any racial discrimination that occurred outside of the home that did not include educational or peer discrimination.
An example includes: "You were hassled by a store clerk or store guard."

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Racial discrimination and diurnal cortisol slope

TABLE 3. Unstandardized β Coefficients and Standardized β Coefficients for Cortisol Patterns

	Unstandardized *B* (SD) / Standardized β							
Context of Racial Discrimination	Baseline Cortisol (Log-Awakening Cortisol)		Log-Diurnal AUCg		Delta 0–30 min		Diurnal Cortisol Slope	
Cumulative racial discrimination	1	−0.014 (0.007) −0.190	5	−0.003 (0.006) −0.040	9	−0.004 (0.003) −0.153	13	**0.010 (0.004)*** **0.225**
Peer racial discrimination	2	−0.031 (0.020) −0.159	6	−0.008 (0.015) −0.045	10	−0.013 (0.008) −0.173	14	**0.023 (0.010)*** **0.224**
Educational discrimination	3	−0.026 (0.020) −0.142	7	−0.012 (0.014) −0.068	11	−0.009 (0.007) −0.126	15	0.015 (0.010) 0.160
Institutional discrimination	4	−0.024 (0.016) −0.154	8	0.016 (0.012) 0.011	12	−0.005 (0.006) −0.076	16	0.013 (0.008) 0.157

SD = standard deviation; AUCg = area under the curve with respect to ground.

Models 1–4 include log-based baseline (awakening) cortisol outcome. Models 5–8 include log-based diurnal cortisol AUCg outcome. Models 9–12 include Δ 0–30 min cortisol outcome. Models 13–16 include diurnal cortisol slope outcome. All models included sex, body mass index percentile, pubertal development, race, and perceived stress as covariates.

Bold font denotes $p < .05$.

* $p < .05$.

JE Emlaw et al, Psychosomatic Medicine, 2023

Stress appraisal

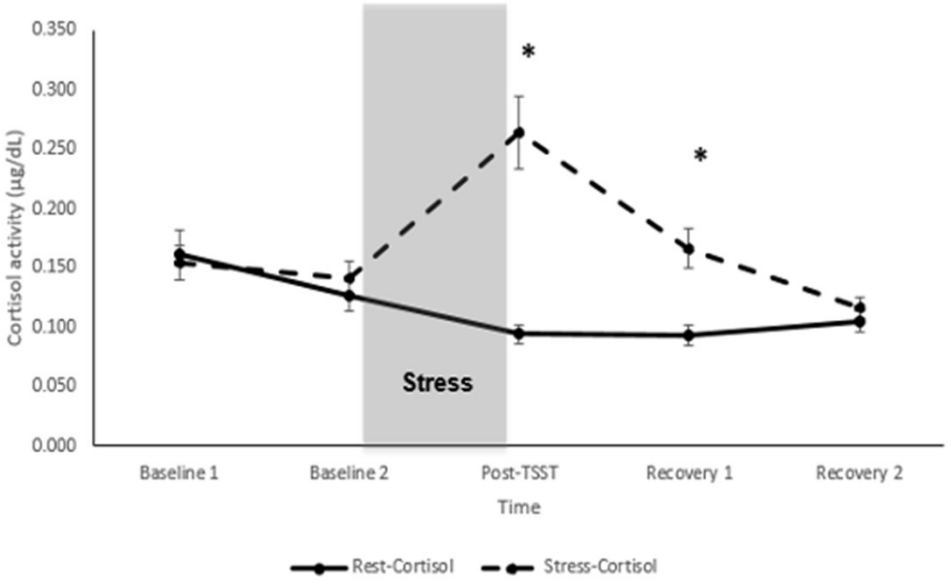
- Challenge stressor- a demanding but controllable situation where a person has adequate resources to cope the stressor
  - Higher SNS activation
- Threat stressor- a demanding situation where one does not have the resources to cope well with, or has the associated components of 'distress' (feeling defeated, fearful)
  - Higher HPA-axis activation

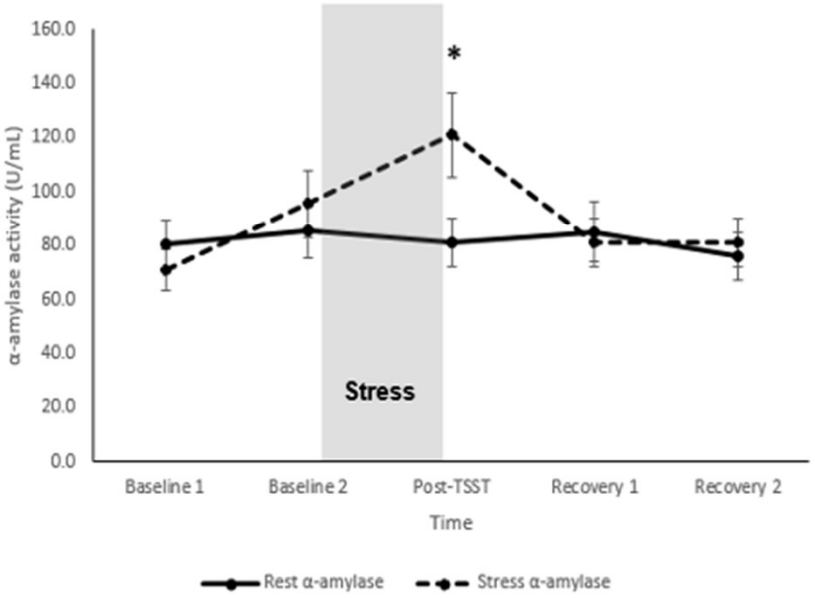
Trier Social Stress Test

TC Adam and E Epel, Physiol Behav., 2007; C Kirschbaum et al., 1993.

Cortisol and cardiovascular reactivity

Trier Social Stress Test





RE Hasson et al., J Interpersonal Violence, 2021

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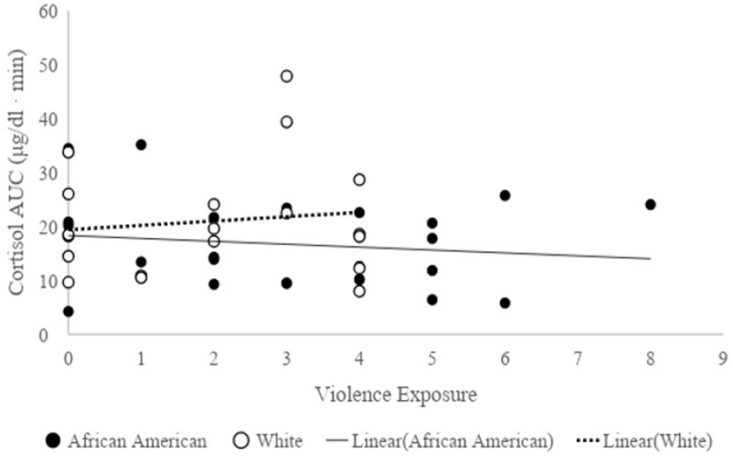
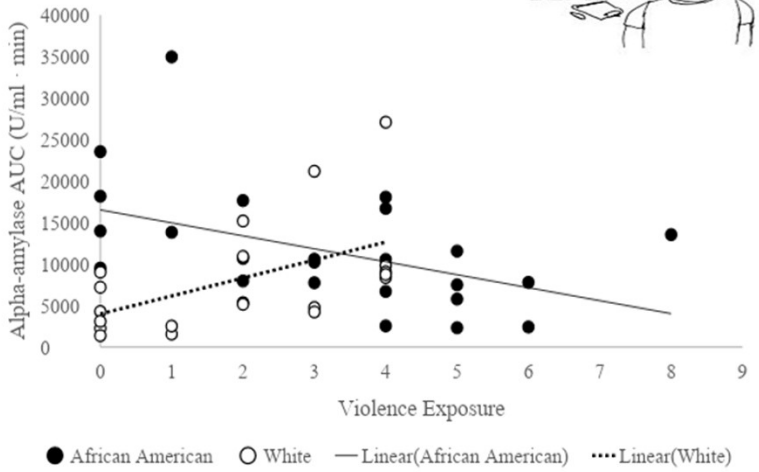
Community violence and stress reactivity

Trier Social Stress Test





- Exposure to community violence may act to exacerbate autonomic dysregulation in African American adolescents with overweight/obesity.
- Exposure to racial discrimination was not associated with stress reactivity.

RE Hasson et al., J Interpersonal Violence, 2021

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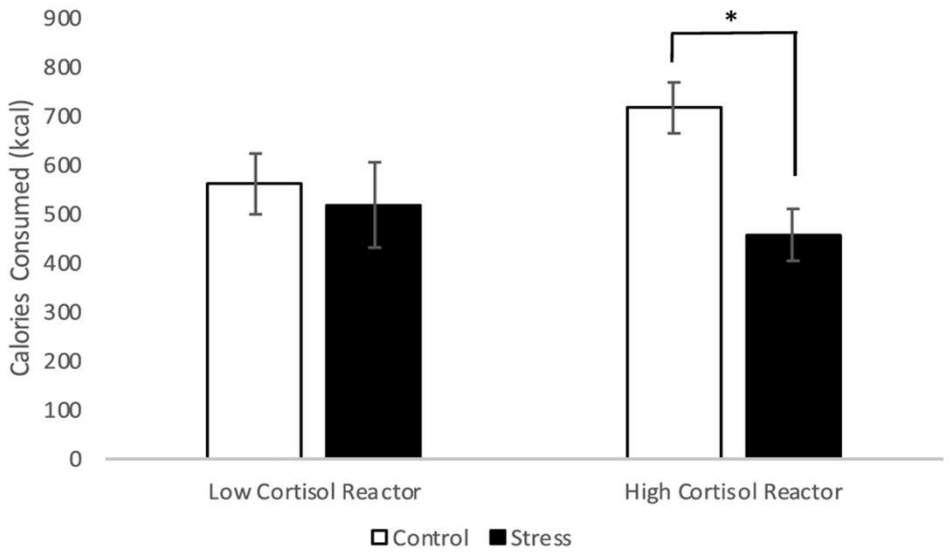
STRESS EXPOSURE
self-reported discrimination, community violence
SOCIETY
SCHOOL
INDIVIDUAL
NEIGHBORHOOD
FAMILY
STRESS APPRAISAL
Demands > Resources
BIOLOGICAL
STRESS RESPONSES
HPA axis activity
BEHAVIORAL
COPING STRATEGIES
stress eating, physical inactivity
TYPE 2 DIABETES RISK
insulin resistance, beta-cell dysfunction

Psychological demands during adolescence

Roemmich et al., ESSR, 2014; Lupien et al., Nature Rev Neurosci., 2009; Goldschmidt et al., Obesity, 2008; Beukes, Walker, and Esterhuyse, Stress and Health, 2010; Rancourt and McCullough, Curr Diab Rep., 2015

Cortisol and stress eating

- Mixed findings between stress and food intake in humans
- Our lab has previously found that following a laboratory stressor, overweight/obese youth do not stress eat



M.R. Nagy et al., Psychosomatic Medicine., 2019

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Psychological stress and disordered eating

- Disordered eating- deviation from normal, socially acceptable, health maintenance-focused approach to food.
  - Extreme caloric restriction
  - Skipping meals
- Our findings: Increased psychological stress was associated with increased dieting behavior among adolescents with overweight/obesity.

Dieting behavior	β	SE	p-value
Dieting			
Psychological stress	0.15	0.06	0.016*
Dieting			
Gender*psychological stress	−0.16	0.14	0.25
Dieting			
Race/ethnicity*psychological stress	0.08	0.12	0.53
Dieting			
Gender*psychological stress	−0.16	0.14	0.27
Race/ethnicity*psychological stress	0.07	0.12	0.61

TA Ajibewa et al., Appetite, 2020; TA Ajibewa et al., Child Obesity, 2021.

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Psychological stress and physical activity participation

Predictors of Moderate-to-Vigorous Physical Activity Stratified by Gender

Predictors	β[a]	SE[b]	p-value	95% CI[c]
Perceived Stress				
Boys	-0.7	0.3	.03*	-1.3, -0.1
Girls	0.3	0.2	.22	-0.2, 0.7
Boys vs Girls	0.9	0.4	.01*	0.2, 1.7

- Psychological stress predicted lowered moderate-to-vigorous physical activity in adolescent boys

KC McGlumphy et al., Am J Health Behav, 2018

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Psychological stress and physical activity enjoyment

- Strongest predictor of continued physical activity participation
- Increased psychological stress is associated with lowered exercise enjoyment

Table 2. Linear Regression Analysis for Psychological Stress, Physical Activity Enjoyment, and Log-Based MVPA Engagement.

	β	SE	p-value
Model 1: Physical activity enjoyment			
Psychological stress	−0.41	0.15	**0.008***
BMI percentile	−0.06	0.15	0.71
Gender	1.78	2.81	0.53
Race	2.10	2.23	0.35
Pubertal category score	−1.12	0.62	0.07
Model 2: MVPA participation			
Psychological stress	0.01	0.02	0.41
BMI percentile	−0.005	0.02	0.76
Gender	−1.05	0.29	**<0.001***
Race	−0.14	0.23	0.54
Pubertal category score	0.005	0.06	0.94
Model 3: MVPA participation			
PA enjoyment	0.02	0.01	0.11
BMI percentile	−0.003	0.02	0.86
Gender	−1.03	0.28	**<0.001***
Race	−0.13	0.22	0.57
Pubertal category score	0.02	0.06	0.80
Model 4: MVPA participation			
Psychological stress*PA enjoyment	<0.001	0.001	0.77
BMI percentile	−0.004	0.02	0.80
Gender	−1.08	0.29	**<0.001***
Race	−0.18	0.23	0.43
Pubertal category score	0.02	0.07	0.73

PA: physical activity; MVPA: Moderate-to-vigorous Physical Activity; * Denotes $p < 0.05$. β: Unstandardized Regression Coefficient.

TA Ajibewa et al, 2021 Am J Health Promotion; 35(6)766-774.

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STRESS EXPOSURE
self-reported discrimination, community violence
SOCIETY
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STRESS RESPONSES
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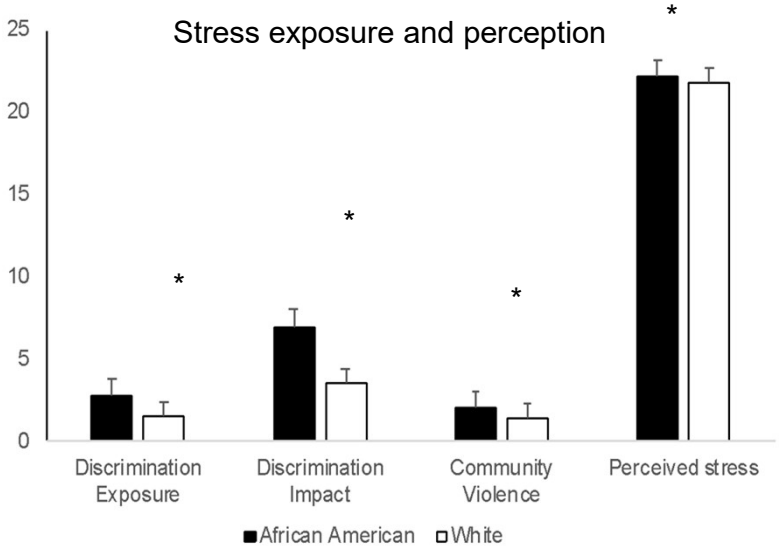
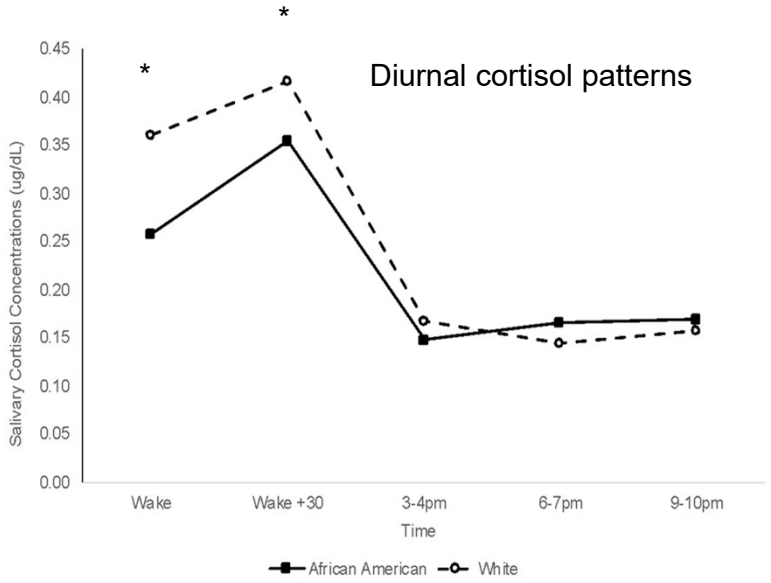
stress eating, physical inactivity
TYPE 2 DIABETES RISK
insulin resistance, beta-cell dysfunction

Racial differences in stress

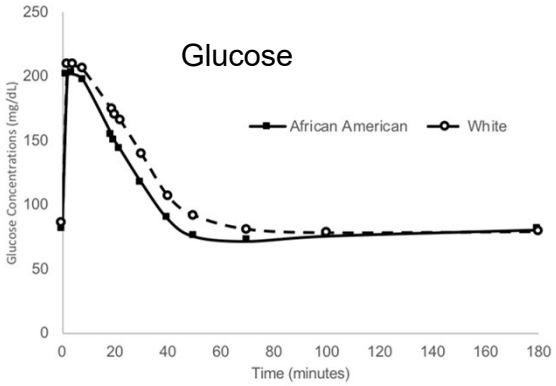


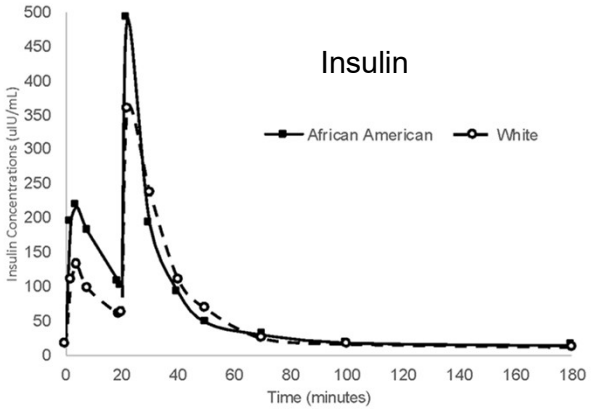


Compared to non-Latino whites, African American adolescents with overweight/obesity reported greater stress exposure and appraisal and exhibited greater dysregulated cortisol responses.

Hasson et al (unpublished data)

Racial differences in glucose metabolism





IVGTT	African-American (mean±SE)	White (mean±SE)	P
Si	2.9±0.4	2.6±0.2	0.31
AIRg	**1448±157**	**921±94**	**<0.001**
DI	**3301±638**	**1853±138**	**<0.001**

Compared to non-Latino whites, overweight/obese African American reported greater AIRg and DI

Hasson et al (unpublished data)

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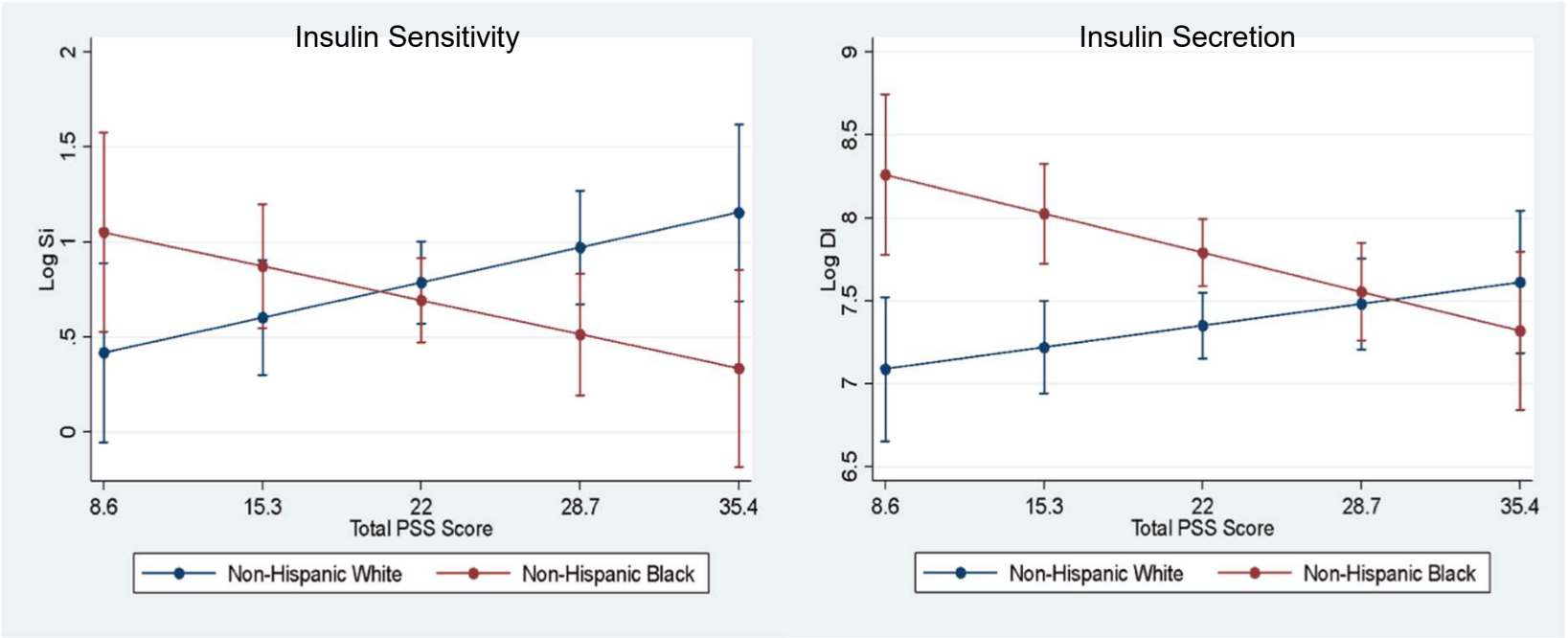
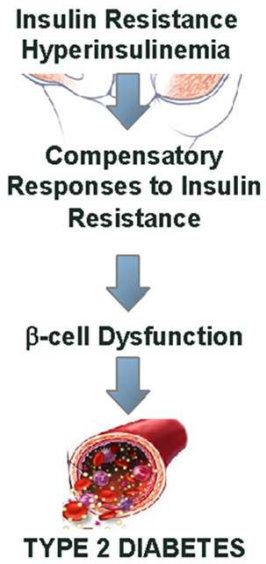
Stress perception and diabetes risk





Paradoxical findings in non-Hispanic whites where type 2 diabetes risk was lower with increased stress.

T.A. Ajibewa et al Physiol Behav. 2021 Dec 11;245:113672.

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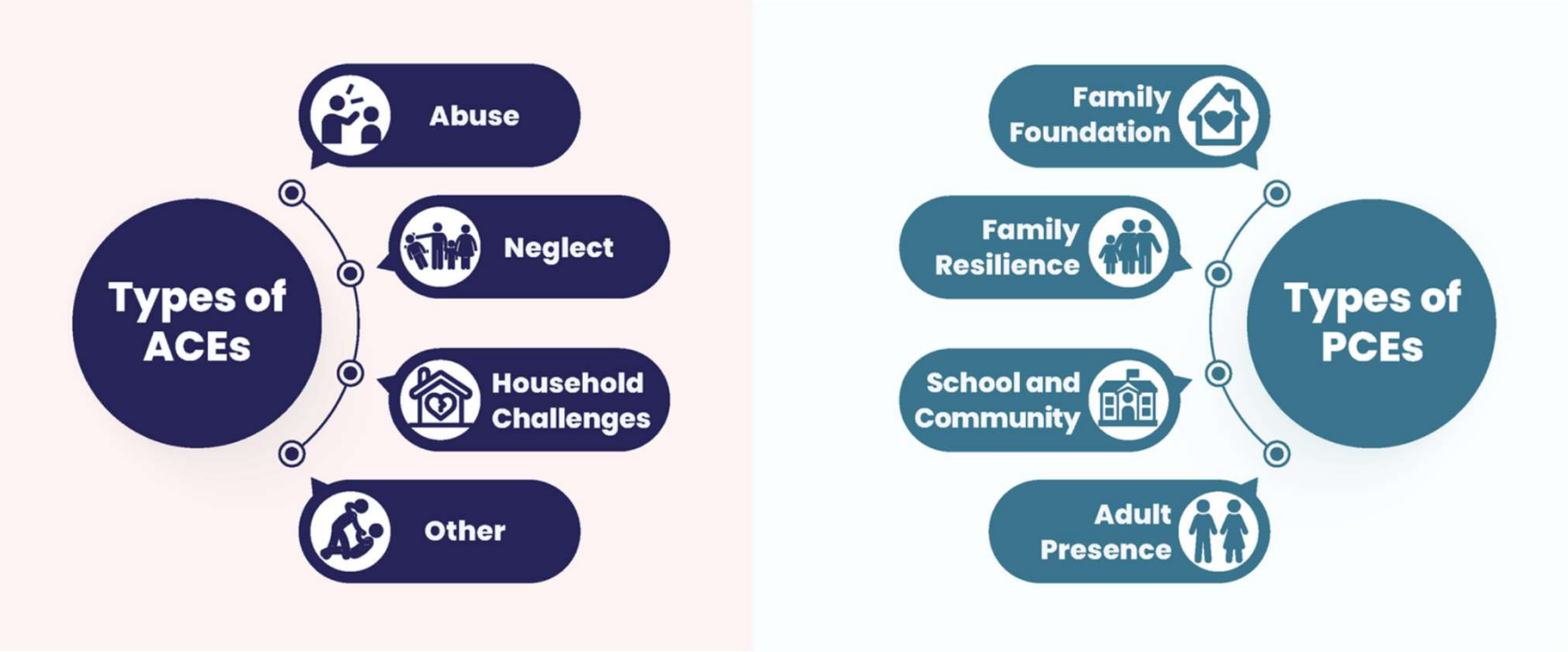
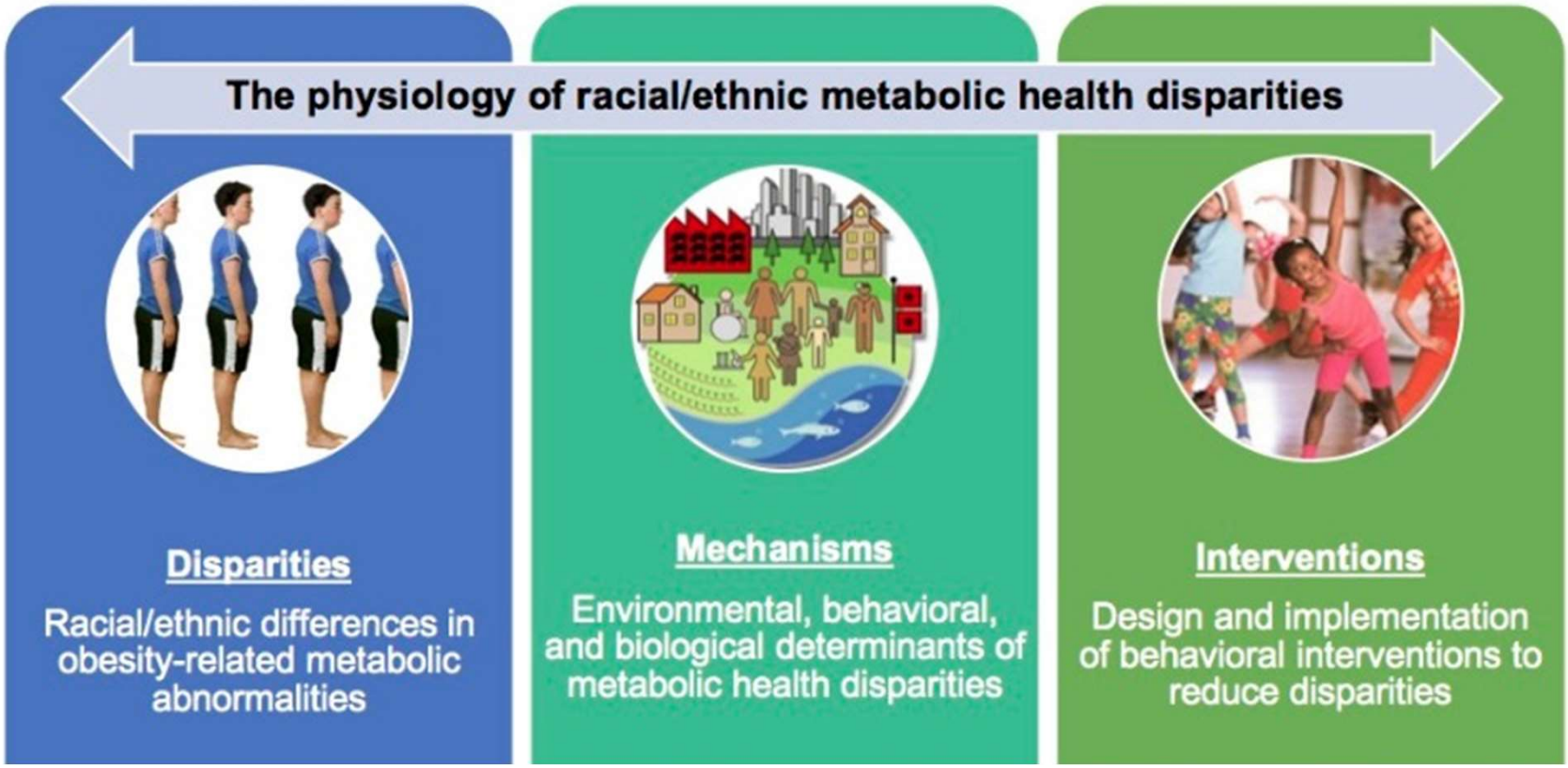
Positive childhood experiences



https://www.ctdata.org/blog/explore-our-data-portal-on-childhood-experiences

Translational research program



Psychoneuroendocrinology (2015) 51, 414–425

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/psyneuen

The stress-buffering effect of acute exercise: Evidence for HPA axis negative feedback

Elisabeth Zschucke[a,b,d,*], Babette Renneberg[b], Fernando Dimeo[c], Torsten Wüstenberg[d,1], Andreas Ströhle[d,1]

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Received 23 May 2014; received in revised form 18 October 2014; accepted 19 October 2014

Stress Buffering with Exercise

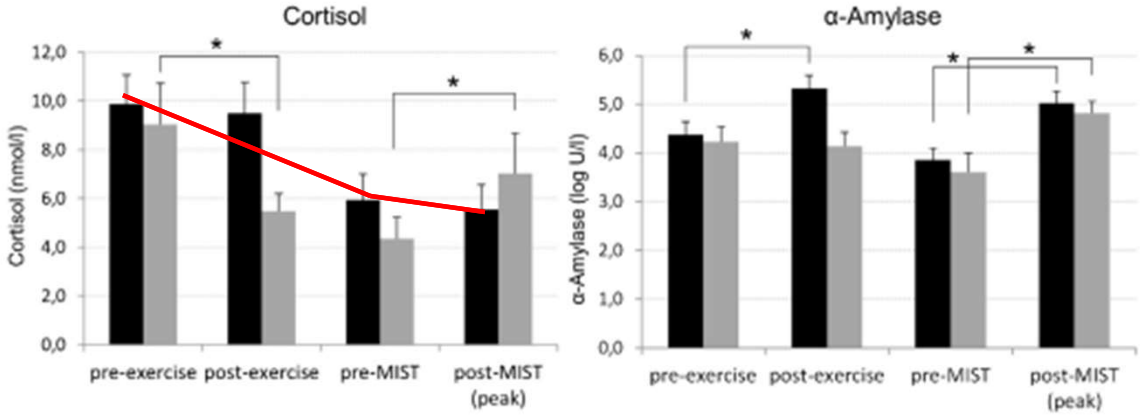

Figure 2 Cortisol (left panel) and α-amylase (right panel) fluctuation prior to and after exercise treatment and the MIST (mean and SEM). Black bars = AER, grey bars = PLAC. Asterisks indicate significant differences ($p \leq .05$).

- 30 min of aerobic exercise are related to:
  - a blunted cortisol response to a subsequent psychosocial stressor
  - feedback inhibition of the HPA system (via sustained hippocampal activation)
  - exercise-induced increase in positive affect (mood)

E. Zschucke et al., Psychoneuroendocrinology, 51:414-425, 2015

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Exercise as a Positive Stressor

- Exercise shares several characteristics of an acute stressor
  - requiring hemodynamic, endocrine, and metabolic adaptations to restore homeostasis
  - SNS and HPA-axis systems are activated in an intensity- and duration-dependent manner
  - Can apply the FITT principle to stress/stress responses
- Voluntary aerobic exercise has been labeled a ‘‘harmless threat to homeostasis’’ due to the absence of features characterizing harmful stressors (force, uncontrollability, and threat) and utilization of energy substrates released

E. Zschucke et al., Psychoneuroendocrinology, 51:414-425, 2015

Cross-Stressor Adaptation Hypothesis

- The repeated physiological challenge of exercise should result in adaptations which lead to a reduced sensitivity to subsequent exercise and even other types of stressors

- In trained persons, SNS and HPA responses to absolute (but not relative and maximal) exercise workload are reduced and recovery happens faster, indicating an adaptation to the exercise stressor

- **Single sessions of aerobic exercise have demonstrated improvements in both cardiovascular and emotional reactivity to stress in children.**

Sothmann et al, 1996; Hackney et al 2006; Gerber et al 2008

D.R. Bassett et al. (2013) Estimated energy expenditures for school-based policies and active living. American Journal of Preventive Medicine, 44(2): 108-113.

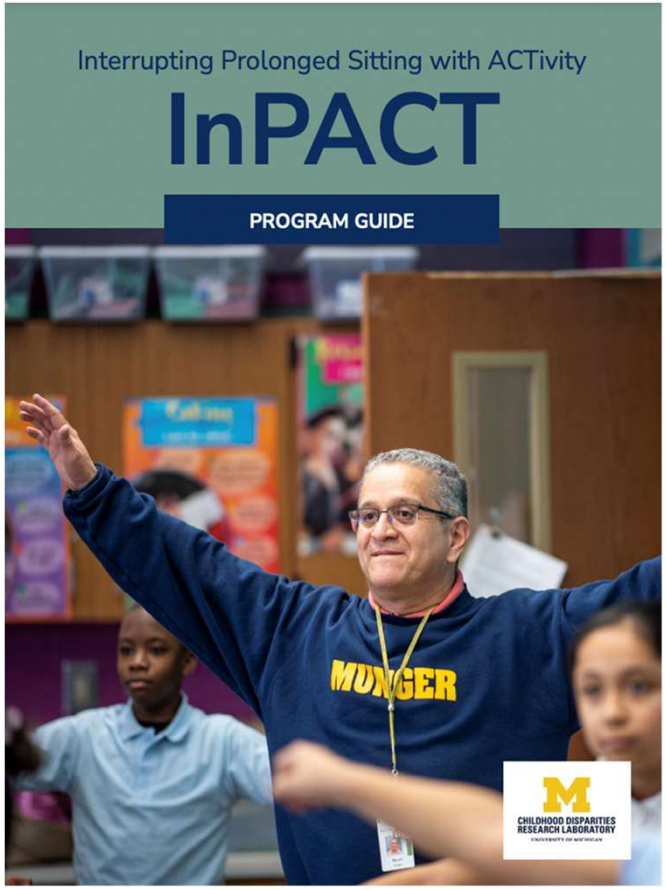
Mental Health Crisis (2022)

- 84% of public schools reported that student behavioral development has been negatively impacted
- 56% increase in student misconduct
- 48% increase in rowdiness
- 48% increase in acts of disrespect to school staff and teachers

Gobel et al, 2016; NCHES, 2023

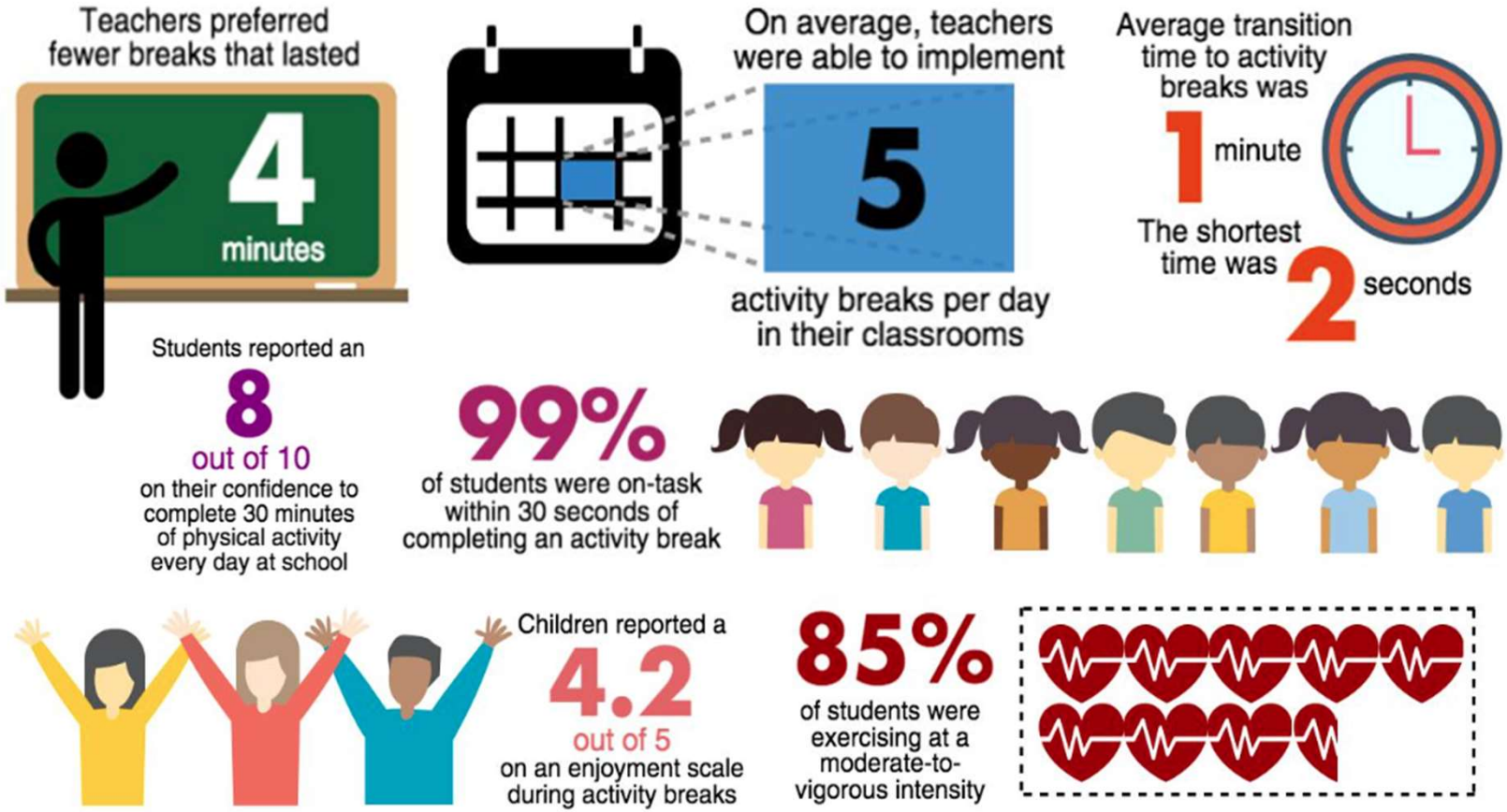
Teacher training

What and Why of Activity Breaks Module 1	InPACT Core Elements Module 2	Floor Plans Module 3
Classroom Management Module 4	Curriculum Integration Module 5	Right Videos Right Intensity Module 6
Student Motivation & Gamification Module 7	Equity & Adaptation Module 8	Safety Considerations Module 9



RE Hasson et al. (2021) Adapting the InPACT Intervention to Enhance Implementation Fidelity and Flexibility. Prev Sci., 22(3):324-333.

InPACT by the numbers



LR Beemer et al. (2018) Feasibility of the InPACT intervention to enhance movement and learning in the classroom. Translational Journal of the American College Sports Medicine, 3(18):136-151.

Teacher feedback

- When asked: *"What, if any, changes have you observed since implementing InPACT?"*
  - **82%** reported fewer behavioral issues, and improved student self-regulation
  - **86%** reported positive mood changes citing student enjoyment, happiness and excitement related to activity breaks
  - **95%** reported improved students' focus, engagement, and the breaks being a productive outlet for energy

RE Hasson et al. (2023) Closing the gap between classroom-based physical activity intervention adoption and use. Kinesiology Review. Kinesiology Review, 12(1), 36-46

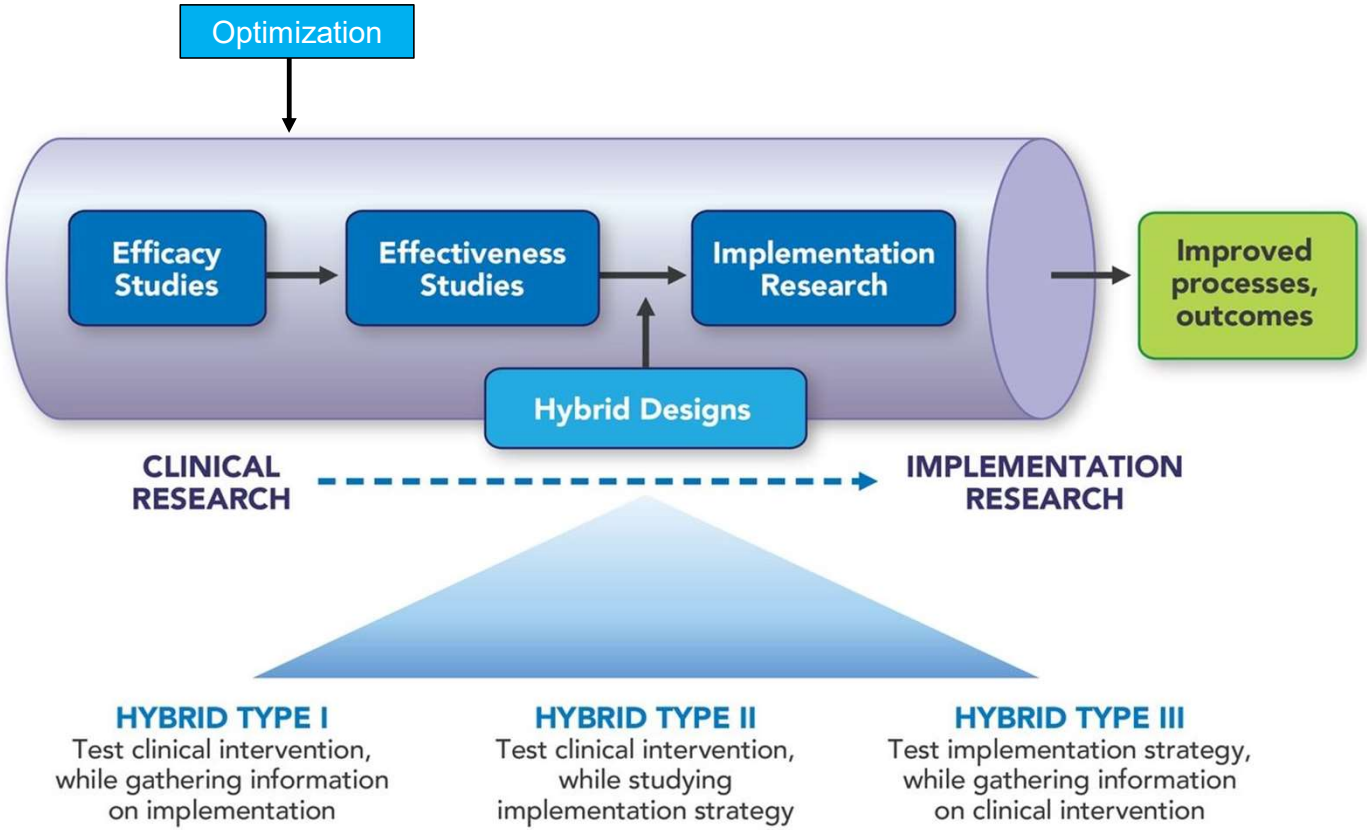
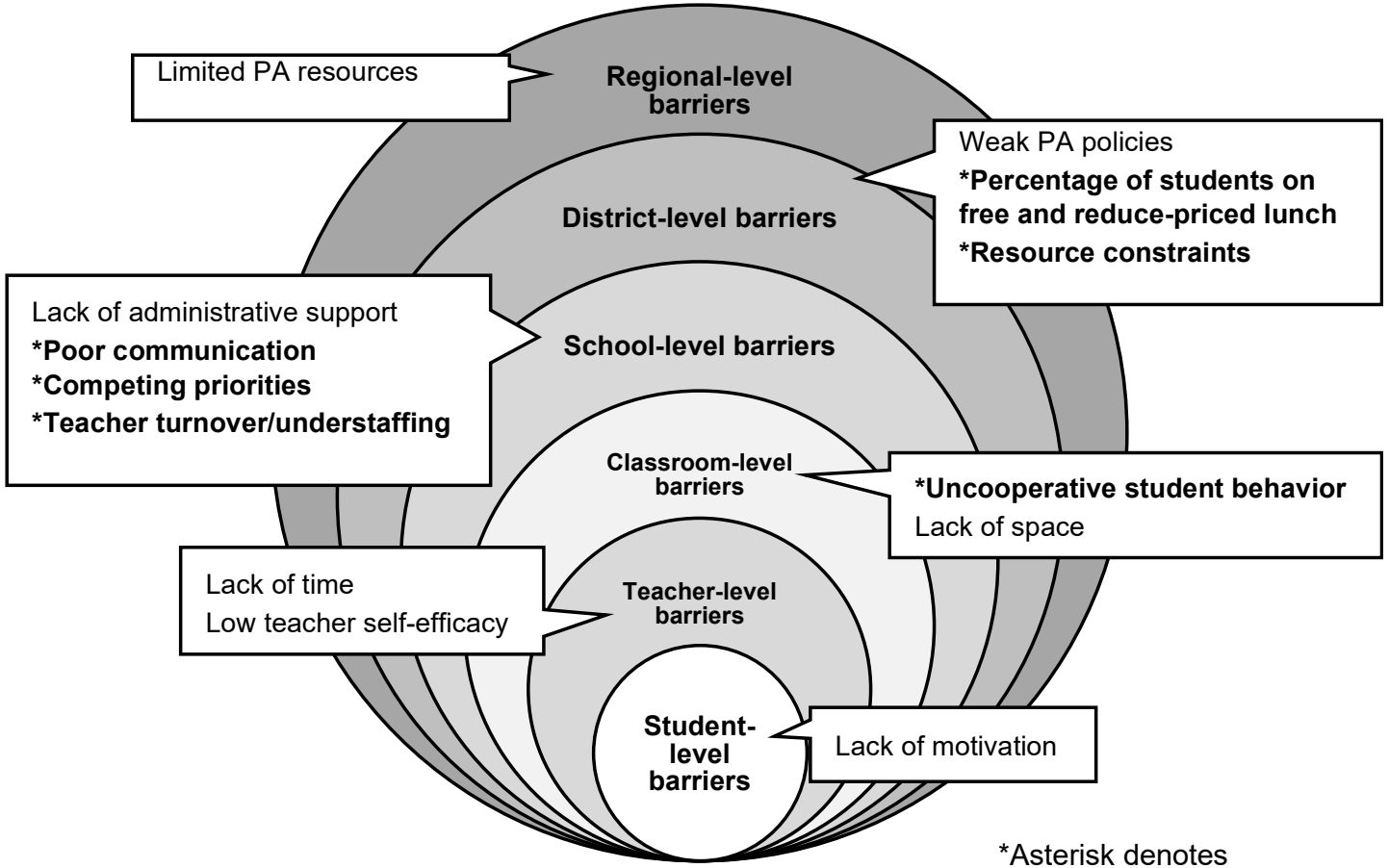


Image source: https://www.evidera.com/wp-content/uploads/2021/05/EFSpr21_A08_HillJ-Science.pdf

Implementation Science
How do we reduce low-fidelity implementation?

Health Equity
How do we overcome the barriers that lead to inequitable implementation?

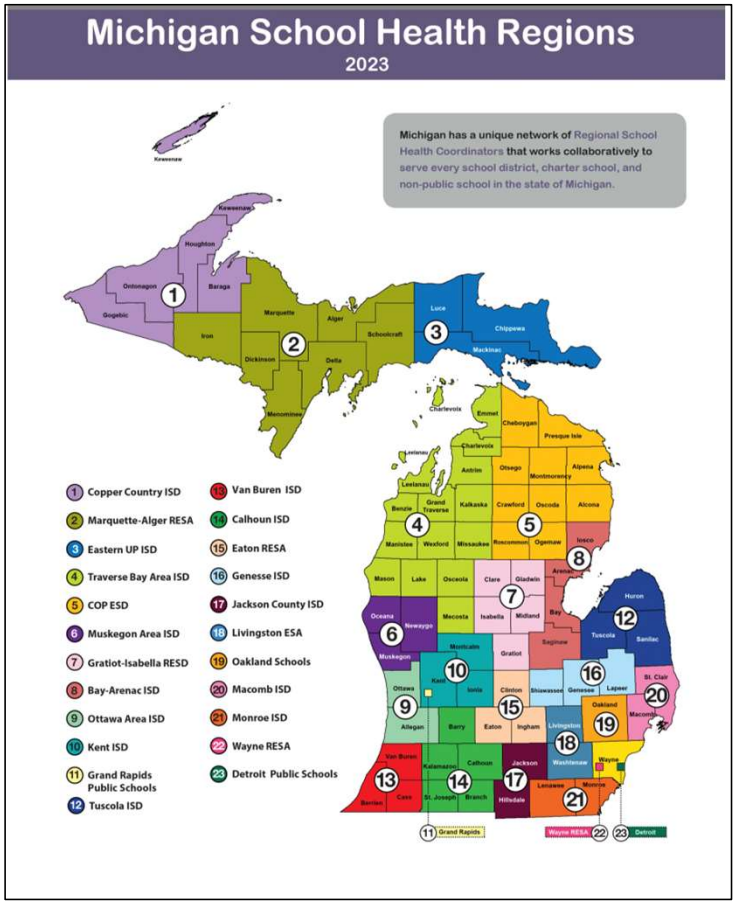
Multi-level supports are needed to overcome to implementation barriers



*Asterisk denotes barriers identified in under-resourced schools

RE Hasson et al. (2023) Closing the gap between classroom-based physical activity intervention adoption and use. Kinesiology Review. Kinesiology Review, 12(1), 36-46

Regional School Health Coordinators



- Network of regional school health coordinators that provide support, training, technical assistance for health programs and practices in schools
- Key facilitators of InPACT implementation

Eisman et al. Pilot and Feasibility Studies, 2022; 8:204; mischca.org

IMPACT at HOME

AS SEEN ON TV

Improving the health and well-being of Michigan children and their families

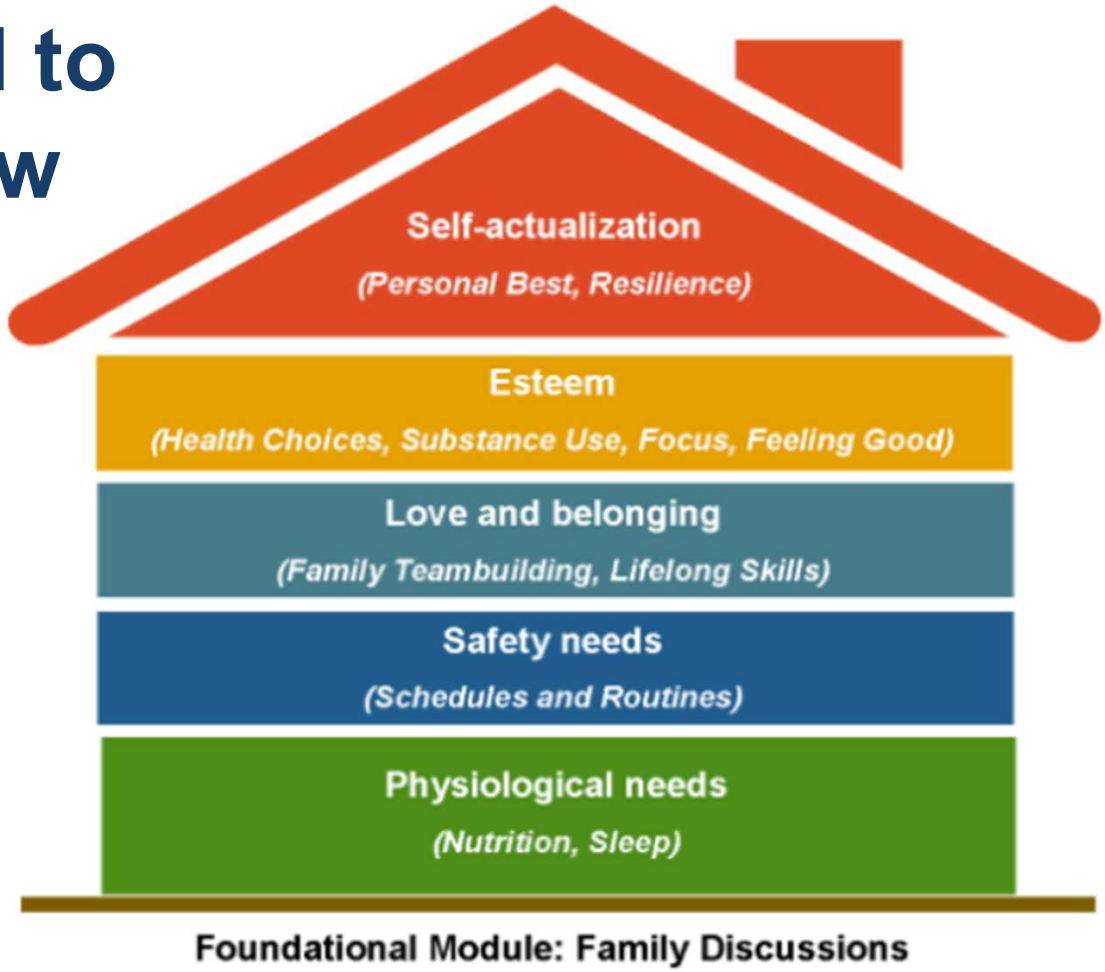
InPACT at Home Family Toolkit

- 12 Modules
- Challenge Calendars →

- Each module addresses how physical activity supports and intersects with another health-enhancing behavior.

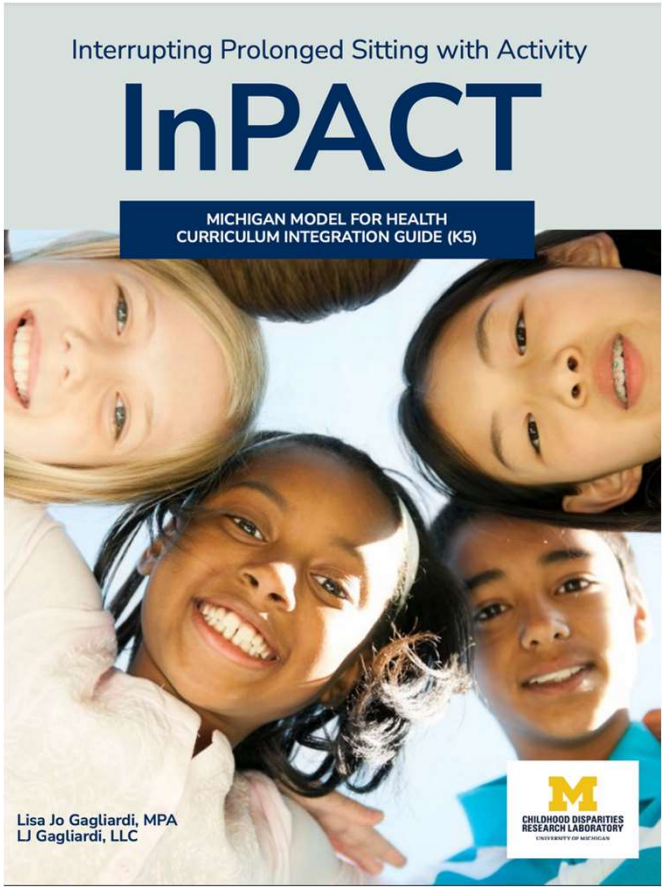
Hasson RE, et al. (2022) Rapid cycle adaptation of a classroom-based intervention to promote equity in access to youth physical activity. Transl Behav Med. Oct 7;12(9):945-955.

Family Toolkit Aligned to Maslow



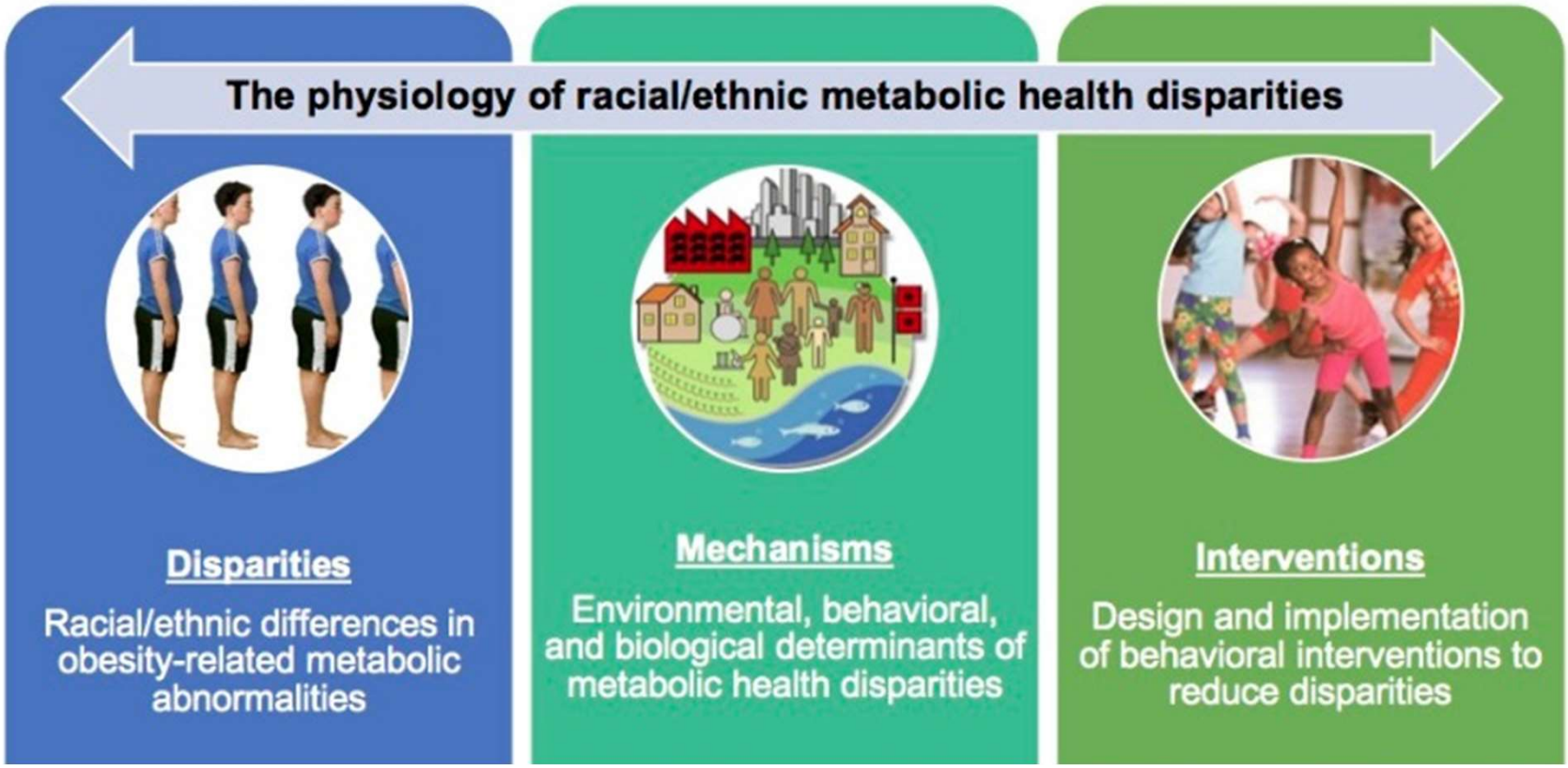
Curriculum Integration

Bringing **InPACT at School** and **InPACT at Home** together through integration with a widely used, evidence-based prevention curriculum: **The Michigan Model for Health™.**



InPACT at School website:
https://www.inpact.kines.umich.edu/ ➡ Teacher Tab

Translational research program



Childhood Disparities Research Laboratory

Visit us at **cdrl.kines.umich.edu**

"Improving the health and well-being of children and their families"

American Diabetes Association®

MDHHS Michigan Department of Health & Human Services

Momentum Center Driving discovery to end childhood obesity

MPHI